FULL TRANSLATION OF Japanese Patent Application

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Specification

1. Title of the Invention

DC-DC Converter Circuit

2. Claims

1. A DC-DC converter circuit comprising;

a plurality of DC-DC conversion sections (2_1, 2_2, through 2_n) for interrupting DC being supplied in parallel from a common supply source (1) and then flattening the interrupted current to supply to a load, and

a driving signal generation section (3) for outputting driving signals (P_1, P_2, through P_n) that control the interruption of DC in each of the plurality of DC-DC conversion sections (2_1, 2_2, through 2_n),

wherein the phases of the driving signals (P_1, P_2, through P_n) for controlling the respective DC-DC conversion sections are fixed so as to minimize the ripples in the sum of currents flowing at the input sides of all of the DC-DC conversion sections (2_1, 2_2, through 2_n).

3. Detailed Explanation for the Invention

[Outline]

The present invention is related to a multi-power DC-DC converter circuit including a plurality of DC-DC conversion sections for receiving a supply of DC electric power from a common DC power supply source and individually performing switching operations to effect DC-DC conversion.

It is an object of the present invention to lower a ripple current to be feedbacked to the common DC power supply source to thereby decrease a load to be imposed to a capacitor for ripple current absorption.

The DC-DC converter circuit according to the present invention comprises a plurality of DC-DC conversion sections for interrupting DC being supplied in parallel from the common supply source and flattening the interrupted current to supply the flattened current to a load and a driving signal generating section for outputting driving signals that control the interruption of the DC at each of the plurality of DC-DC conversion sections,

the phases of the driving signals for controlling the respective DC-DC conversion sections are configured such that the ripples in the sum of currents flowing at the input sides of the respective DC-DC conversion sections are minimized.

[Industrial Uses]

The present invention relates to a DC-DC converter circuit, and particularly to a multi-power DC-DC converter circuit including a plurality of DC-DC conversion sections for receiving a supply of DC power from a common DC power supply source and individually performing switching operations to effect DC-DC conversion.

In order to convert a DC obtained by commutation-flattening an AC supplied from a commercially available AC power source into an AC voltage in the form being required in each of the plurality of portions within the same apparatus and then supply the AC voltage to said plurality of portions, a multi-power DC-DC converter circuit structured by including a plurality of DC-DC conversion sections, each of those which individually performs switching operations to thereby effect DC-DC conversion, is used.

However, in such a multi-power DC—DC converter circuit, there is a problem where a ripple current at an input side is increased relative to the output electric power. Therefore, a solution for lowering the ripple current at an input side has been sought.

[Prior Art]

FIG. 4, a configuration of a DC-DC converter circuit of the series resonance type is illustrated as an example of a circuit wherein a ripple current at an input side being particularly prominent among the conventional multi-power DC-DC converter circuits. In FIG. 4, a reference sign 11 represents

a DC power supply source for supplying a DC power obtained by commutation-flattening an AC supplied from a commercially available AC power source as described above. A DC power supplied from the DC power supply source 11 is supplied to two DC-DC conversion sections 2_1 and 2_2 respectively configured around a high-frequency transformer 23 or 43 having a primary coil of the center-tap type. To the primary side of the high-frequency transformer 23 or 43 in the respective DC-DC conversion section 2_1, 2_2, a DC voltage in the reverse direction is alternately impressed by means of switching elements 21, 22 or 41, 42 for alternately turning on and off. To the secondary side of the respective high-frequency transformers 23 and 43, series resonance circuits 24, 25 or 44, 45, commutation circuits 26, 27, 28, 29 or 46, 47, 48, 49, and a smoothing capacitor 30 or 50 are provided, and the power of the respective DC-DC conversion section 2_1, 2_2 configured as described above is supplied respectively to the load 31 or 51. The foresaid switching elements 21, 22, 41, 42 are respectively controlled by a driving signal sent from a driving signal generation section 3', while, in the DC-DC converter circuit being conventionally used, driving signals of the same phase were impressed from a driving signal generation section to the plurality of DC-DC conversion sections. In the configuration shown in FIG. 4, for example, a pair of driving signals P_1, $\overline{P_1}$ being opposite in the phases to each other are impressed from the driving signal generation section 3' to the pairs of the switching elements 21, 22 and 41, 42 in both of the DC-DC conversion section 2_1, 2_2.

[Problems to be solved by the Invention]

In the above-described configuration, when the phases of the driving signals for controlling the switching operations in the plurality of DC-DC conversion sections coincide with each other, the phases of the wave crest and wave valley of a current wave form at the input side in the respective DC-DC conversion section coincide with each other, as shown in FIG. 5. Since DC current is supplied in parallel from a common DC power supply source 11 to the DC-DC conversion sections as described above, a current outputted from the DC power supply source 11 comes to be equal to the sum of the currents with which the phases of the wave crests and wave valleys at the input sides of all of the DC-DC conversion sections coincide. Thus, the current becomes a current containing large ripples. Since such a ripple current is a cause of a feedback noise to the DC power supply source 11, a capacitor as represented with a reference sign 12 in FIG. 4 is provided in order to absorb the ripple current. However, there has been such a problem that a capacitor with a large capacity is required to absorb the current containing large ripples as described above (as represented with a reference sign Ic in FIG. 5) and the longevity of the capacitor gets shortened due to heat generation caused by the large ripple current flow.

The present invention is motivated by the above-mentioned problem, and it is an object of the present invention to provide a multi-power DC-DC converter circuit comprising a plurality of DC-DC conversion sections for individually performing a switching operation to effect DC-DC conversion and being capable of lowering a ripple current to be feedbacked to a common DC

power supply source to thereby decrease a load onto a capacitor for ripple current absorption.

[Means for solving the Problem]

FIG. 1 is a basic configuration view of the present invention. In this figure, a reference sign 1 represents a DC power supply source, 21, 22 through 2n represent a plurality of DC-DC conversion sections, and 3 represents a driving signal generation section.

The plurality of DC-DC conversion sections 2_1, 2_2 through 2_n respectively interrupt DC having been supplied in parallel from the common DC power supply source 1 and then flatten the interrupted current to supply to a load. The driving signal generation section 3 outputs driving signals P_1, P_2 through P_n, those which control the interruption of DC in the respective DC-DC conversion sections 2_1, 2_2 through 2_n. Then, the phases of the driving signals P_1, P_2 through P_n for controlling the respective DC-DC conversion sections 2_1, 2_2 through 2_n are fixed so as to minimize the ripples in the sum of the currents flowing at the input sides of all of the DC-DC conversion sections 2_1, 2_2 through 2_n.

[Operations]

The phases of the driving signals for controlling the switching operations in the respective DC-DC conversion section 2_1, 2_2 through 2_n correspond to the phases of the currents at the respective input sides of the DC-DC conversion sections 2_1, 2_2 through 2_n. Hence, the phases of the driving signals may be fixed so that the positions of the wave crests and wave valleys in the currents flowing at the input sides of the respective

DC-DC conversion sections 2_1, 2_2 through 2_n are distributed uniformly as much as possible to thereby minimize the ripples in the sum of the currents flowing at the input sides of all of the DC-DC conversion sections 2_1, 2_2 through 2_n.

[Examples]

FIG. 2 is a circuit configuration view of an example according to the present invention. In FIG. 2, a reference sign 11 represents a DC power supply source, 12 represents a capacitor for ripple current absorption, 21, 22, 41 and 42 respectively represent a switching element, 23 and 43 respectively represent a high-frequency transformer, 24 and 44 respectively represent a coil, 25 and 45 represent respectively a capacitor, 26, 27, 28, 29, 46, 47, 48 and 49 represent respectively a diode, 31 and 51 respectively represent a load, and 3 represents a driving signal generation section. In the configuration shown in FIG. 2, the configuration other than the driving signal generation section 3 for controlling the respective switching elements 21, 22, 41, 42 is same as the configuration shown above in FIG. 4. Specifically, the DC power supply source 11 is structured to supply DC power obtained by commutation-flattening AC having been supplied from a commercially available power source, and the DC power supplied from the DC power supply source 11 is supplied to two DC-DC conversion sections 2_1, 2_2 being structured around a high-frequency transformer 23 or 43, respectively, having a center-tap-shaped primary side coil. To the primary side of the high-frequency transformer 23 or 43 in the respective DC-DC conversion sections 2_1, 2_2, a DC voltage in the reverse direction is alternately impressed by the switching elements

21, 22 or 41, 42 for alternately turning on and off. To the secondary side of the respective high-frequency transformers 23 and 43, a commutation circuit consisting of series resonance circuits 24, 25 or 44, 45, diodes 26, 27, 28, 29 or 46, 47, 48, 49 and a smoothing capacitor 30 or 50 are provided, and the power of the DC-DC conversion sections 2_1, 2_2 being configured as described above is supplied to the load 31 or 51, respectively. Further, in order to absorb the feedback noise to be feedbacked to the DC power supply source 11 side, a capacitor for ripple current absorption is provided in parallel to the both terminals of the DC power supply source 11.

In the configuration shown in FIG. 2, the driving signal generation section 3 impresses the driving signals P_1, $\overline{P_1}$, which are in a reverse phase relation, to the respective switching elements 21, 22 in one DC-DC conversion sections 2_1, while impresses driving signals P_2, $\overline{P_2}$, which are in a reverse phase relation, to the switching elements 41 and 42 in the other DC-DC conversion section 2_2. At this occasion, there is a phase difference of 90° between the driving signals P_1 and P_2. Because of that, the phases of the wave crest and wave valley in the wave form of a current I_1 at the input side of one 2_1 of the two DC-DC conversion sections 2_1, 2_2 each having a sine-wave is deviated by 90° with respect to the phases of the wave crest and wave valley in the wave form of a current I_2 at the input side of the other DC-DC conversion section 2_2, respectively. As a result, a current I_e flowing into the capacitor for the ripple current absorption 12 becomes a current containing small-sized ripples as shown in FIG. 3. Therefore, the capacitor for ripple current absorption is enough to have a small capacity. With such

a capacitor having a smaller capacity, heat generation caused by the ripple current flow may be decrease and the longevity of the capacitor could be longer.

In the description given above, although the present invention is explained as embodied in a DC-DC converter circuit of the series resonance type, when there are n pieces of DC-DC conversion sections in the circuit, the phases of the driving signals to be impressed to the respective DC-DC conversion sections may be deviated by π/n in general. Note that the present invention may be applied to all DC-DC converter circuits of all the other types and in the other power manner.

[Advantageous Effect of the Invention]

According to the present invention, it is possible to lower a ripple current to be feedbacked to a common power supply source and decrease a load to be impressed to the capacitor for ripple current absorption in the multi-power DC-DC converter circuit configured by containing a plurality of DC-DC conversion sections which perform switching operations individually to effect DC-DC conversion.

4. Brief Explanation of the Drawings

FIG. 1 is a basic configuration view of the present invention;

FIG. 2 is a circuit configuration view of an example for the present invention;

FIG. 3 is a timing diagram of switching in an example for the present invention;

FIG. 4 is a view showing a configuration example for a

multi-power DC-DC converter circuit of the conventional type; and

FIG. 5 is a timing diagram of switching in a multi-power DC-DC converter circuit of the conventional type.

[Explanation for Reference Signs]

1, 11: DC power supply source

2_1, 2_2, through 2n: DC-DC conversion section

3, 3': Driving signal generation section

12: Capacitor for ripple current absorption

21, 22, 41, 42: Switching element

23, 43: High-frequency transformer

24, 44: Coil

25, 30, 45, 50: Capacitor

31, 51: Load

IN THE DRAWINGS:

Fig. 1: BASIC CONFIGURATION VIEW OF THE PRESENT INVENTION

1 DC power supply source

2_1 First DC-DC conversion section

2_2 Second DC-DC conversion section

2_n n^{th} DC-DC conversion section

Fig. 2: CIRCUIT CONFIGURATION VIEW OF AN EXAMPLE FOR THE PRESENT INVENTION

3 Driving signal generation section

Fig. 3: TIMING DIAGRAM OF SWITCHING IN EXAMPLE OF THE PRESENT INVENTION

Fig. 4: EXAMPLE OF CONVENTIONAL TYPE MULTI-POWER DC-DC CONVERTER CIRCUIT

Fig. 5: TIMING DIAGRAM OF SWITCHING IN THE CONVENTIONAL DC-DC CONVERTER CIRCUIT